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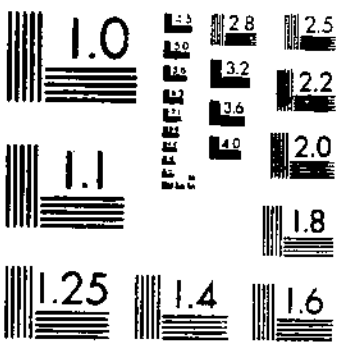

MICROCOPY RESOLUTION TEST CHART
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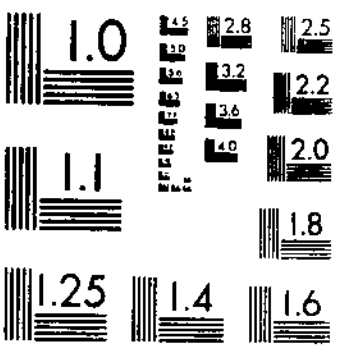

MICROCOPY RESOLUTION TEST CHART
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Response of Cotton to 2,4-D and Related Phenoxy Herbicides

Technical Bulletin No. 1289

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE
in cooperation with the
California Agricultural Experiment Station

Contents

Washington, D.C. Issued September 1963

Response of Cotton to 2,4-D and Related Phenoxy Herbicides

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Although 2,4-D and related phenoxy herbicides have been widely used for the selective control of weeds in many agricultural crops, some crops can be easily damaged by them. Studies on the response of cotton to these herbicides are reported in this bulletin.

In previous studies on the response of cotton to ester formulations of several phenoxy acids, Behrens et al. (*2*)[1] showed that 2,4-D caused the greatest damage to cotton followed by 2,4,5-T, MCPA, and silvex.[2] Goodman et al. (*3*) reported that 2,4-D damaged cotton far more than the other three herbicides. Watson (*4*) concluded that 2,4-D and MCPA caused similar damage to cotton, but both herbicides were more toxic than 2,4,5-T or silvex. He also observed that low rates of these compounds had stimulatory effects on cotton yield. Arle (*1*) reported that when 2,4-D was added to irrigation water, it had a stimulatory effect on cotton yield. He noted that foliage applications of 2,4-D caused a delay in crop maturity, but during a long growing season such a delay could result in increased yields.

[1] Italic numbers in parentheses refer to Literature Cited, p. 28.

[2] 2,4-D=2,4-dichlorophenoxyacetic acid; 2,4,5-T=2,4,5-trichlorophenoxyacetic acid; MCPA=2-methyl-4-chlorophenoxyacetic acid; silvex, originally 2-(2,4,5-TP)=2-(2,4,5-trichlorophenoxy)propionic acid.

MATERIALS AND METHODS

The experiments summarized in this bulletin were conducted at the U.S. Cotton Field Station, Shafter, Calif., over a period of 6 years. For clarity they are summarized as four major studies, each spanning a 2-year period.

Response of Cotton to Foliage Applications of Herbicides

Cotton, variety Acala 4–42, was treated at the early-square, full-bloom, and early-boll stages of growth with the propylene glycol butyl ether ester formulation of two phenoxyacetic acids—2,4-D and 2,4,5-T—and two phenoxypropionic acids—2-(2,4-DP)[3] and silvex. The herbicides were applied as topical foliage sprays at acid equivalent rates of 0.001, 0.01, and 0.1 pound in 100 gallons of water per

[3] 2-(2,4-dichlorophenoxy)propionic acid.

acre. During the first year of the study the 0.1-pound rate was discarded after the first date of application and was replaced by 0.0001 pound per acre. The plots were 33 feet long. Each had a single row in 1954 and three rows in 1955. The experimental design was a randomized block replicated four times. Individual sprayers for each herbicide were used to avoid contamination. Yield data were obtained by hand picking a single row, 33 feet long, in each plot. Plant malformations were pictorially recorded throughout the season.

Response of Cotton to Soil Applications of Herbicides

Aqueous solutions of an alkanolamine salt formulation of 2,4-D and MCPA were injected into the soil by attaching tractor-mounted spraying equipment to soil-fumigation injection shanks. The soil injections were 6 inches deep and 10 inches from the cotton row on each side. In 1956, 2,4-D was applied at 0.5, 0.75, 1.0, and 1.5 pounds per acre based on broadcast coverage and in 1957 at 0.01, 0.025, 0.10, and 0.25 pound per acre. MCPA was used at 0.25, 0.50, 0.75, and 1.0 pound per acre in 1956 and 0.10, 0.25, and 0.50 pound per acre in 1957. Each herbicide was applied in 15 gallons of water per acre.

In 1956 the cotton was approximately 10 inches tall and in the midsquare stage of development at the time of the herbicide treatment. In 1957 the applications were made on two dates. At the early date the cotton plants were 5 to 6 inches tall with very few squares. At the later date the cotton plants were approximately 10 inches tall and in the midsquare stage of development (comparable to 1956). The cotton treated at the early date was grown under a program of restricted irrigation and frequently showed symptoms of water stress. The cotton treated at the later date received normal irrigation.

The plots had two rows and were 130 feet long. The experimental design was a randomized block with three replications. Yields were obtained by machine picking both rows. Typical abnormalities in the plants were recorded pictorially. Samples for seed and fiber evaluations were collected in 1957 from randomly selected plants before harvest.

Response of Cotton to Simulated Drift Rates of an Alkanolamine Salt Formulation of 2,4-D

An alkanolamine salt formulation of 2,4-D at 0, 0.00001, 0.0001, 0.001, 0.01, and 0.1 pound in 30 gallons of water per acre was applied in 1958 and 1959 as foliar treatments on cotton at monthly intervals beginning on May 15 and continuing through August 15. In 1959 the 0.00001-pound rate was discarded. It was realized that 30 gallons per acre did not simulate drift conditions, but this volume was considered necessary to assure good distribution of the herbicide at the time of application. The experimental design was a randomized block with five replications. Each plot had four rows and was 100 feet long. However, since only the two center rows were sprayed, two guard rows were left between treatments. Plywood shields were used to confine the spraying pattern to a uniform 60-inch band.

The plots were sprayed from 6 to 9 a.m. on each application date. Wind velocities varied from 0 to 5 miles per hour. The spray boom

was maintained at 14 inches above the cotton foliage at each application date.

The cotton-plant development at each application date was as follows:

Date	*Plant height (inches)*	*Plant growth*
May 15	4–6	3–4 true leaves.
June 15	15–17	Plant nearly at first bloom.
July 15	24–36	Lower bolls near full size.
August 15	40–50	Fully developed bolls, few opened bolls on lower half of plant.

The plots were machine harvested at the normal picking time and again after a killing frost. Samples of seed cotton for seed and fiber evaluation were obtained by harvesting complete plants selected at random throughout each plot before harvest. Plant malformations were recorded at frequent intervals throughout the season. Pictorial records of individual plant responses to the treatment were made after each herbicide treatment.

Progeny Response of Cotton Treated With Herbicides

Seed was collected after several of the herbicide treatments. The seed cotton was ginned on a small roller gin. The seeds were saved and the fiber was submitted to the fiber laboratory for evaluation. Before planting, the seeds were acid delinted and received a normal fungicide treatment. In the acid-delinting process, floating seeds were discarded in 1957, but they were saved in 1958. Cottonseed from plants that received soil-injected treatments of 2,4-D and MCPA in 1956 was planted in the conventional manner in the field on April 15, 1957. The experimental design was a randomized block with four replications. The plot had one row and was 100 feet long. Emergence counts were made 14, 15, 16, 17, and 37 days after planting. Seedling vigor and growth malformations were recorded. The cotton stand was equalized by hand thinning to 26,000 plants per acre on May 28, and seed cotton yields were obtained at harvest.

In 1958, the 1956 seed was again planted on April 11 along with seed saved from similar 1957 studies. The herbicide application rates in the 1956 and 1957 studies were not similar (see tables 7 and 8). As in 1957, all seed received a normal fungicide treatment before planting. The experimental design was a randomized block with five replications. The plot had one row and was 100 feet long. Emergence counts were made 6, 7, 8, 10, 12, 17, and 24 days after planting. Seedling vigor and growth malformations were recorded. The cotton stand was equalized by hand thinning to 32,500 plants per acre on May 19 and yields of seed cotton were obtained at harvest.

Cottonseed saved from the 1958 studies, in which cotton was treated with foliar sprays of 2,4-D, was planted in 1959. The seeds were acid delinted and treated with a standard fungicide treatment. All seeds, including those floating, were saved. Lots of 25 seeds per herbicide treatment were randomly selected and planted in rows in flats in the greenhouse on April 10. The seeds were uniformly planted at a depth of 1 inch. The experimental design was a randomized block with five replications. Emergence counts were made at 4 p.m. on 8 days after the first emergence.

Seeds from the same lots were also planted in nonreplicated 500-foot rows in the field on April 6. These plants were observed for 2,4-D symptoms and were harvested for yield in the fall.

RESULTS AND DISCUSSION

Response of Cotton to Foliage Applications of Herbicides

When the cotton plants were in the early-square stage of development, the phenoxyacetic acids and phenoxypropionic acids caused epinastic responses in the plants in 2 to 3 hours. Both groups of herbicides likewise produced an apparent increase in red pigmentation. Red pigmentation was most pronounced after treatment with the phenoxypropionic acids. The secondary-growth responses were quite different. The phenoxyacetic acids caused a characteristic "strapping" of leaves, in which the development of the vascular system of the leaf appeared to exceed greatly the development of the remainder of the leaf. The vascular system of plants treated with the phenoxypropionic acids appeared to be retarded, and "cupping" of the leaves resulted rather than strapping. Another characteristic of the latter group was a temporary reduction in the rate of elongation of the internodes of the secondary growth. Both groups of herbicides caused the plants to be extremely brittle for several weeks after treatment.

Seven weeks after the herbicide treatment of cotton in the early-square stage of development, 0.1 pound per acre of all four herbicides had killed the terminals of the cotton plants. Only 2,4-D at 0.01 pound per acre had killed an occasional terminal. The plant terminals survived treatment at the 0.01-pound rate with 2,4,5-T, 2-(2,4-DP), and silvex. None of the herbicide treatments caused death of terminals when 0.001 pound per acre was used. Injury, as measured by leaf malformation, was greatest with 2,4-D, followed by 2,4,5-T, 2-(2,4-DP), and silvex. The difference in plant response to the phenoxyacetic acids and the phenoxypropionic acids was very marked.

In 1954 many of the plants in which the terminals were killed failed to recover and a very poor stand resulted. In 1955 very few of the plants were killed and regrowth from lateral buds occurred. Growth from the lateral buds of most plants appeared near normal,

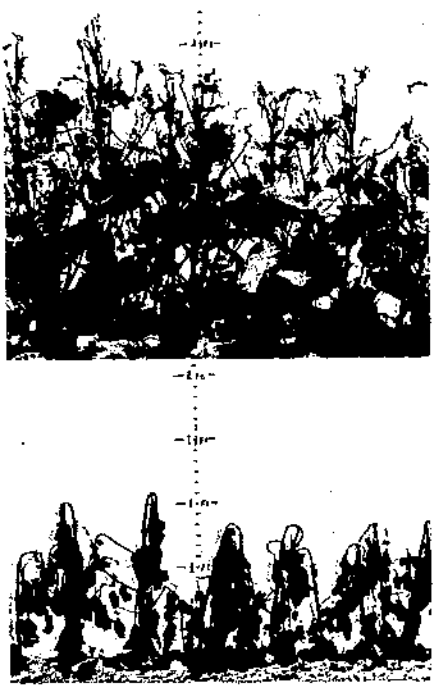

FIGURE 1.—Plant response 1 month after treatment to 0.001 (top) and 0.1 (bottom) pound per acre of 2,4-D applied as foliar sprays to cotton at the early-square stage.

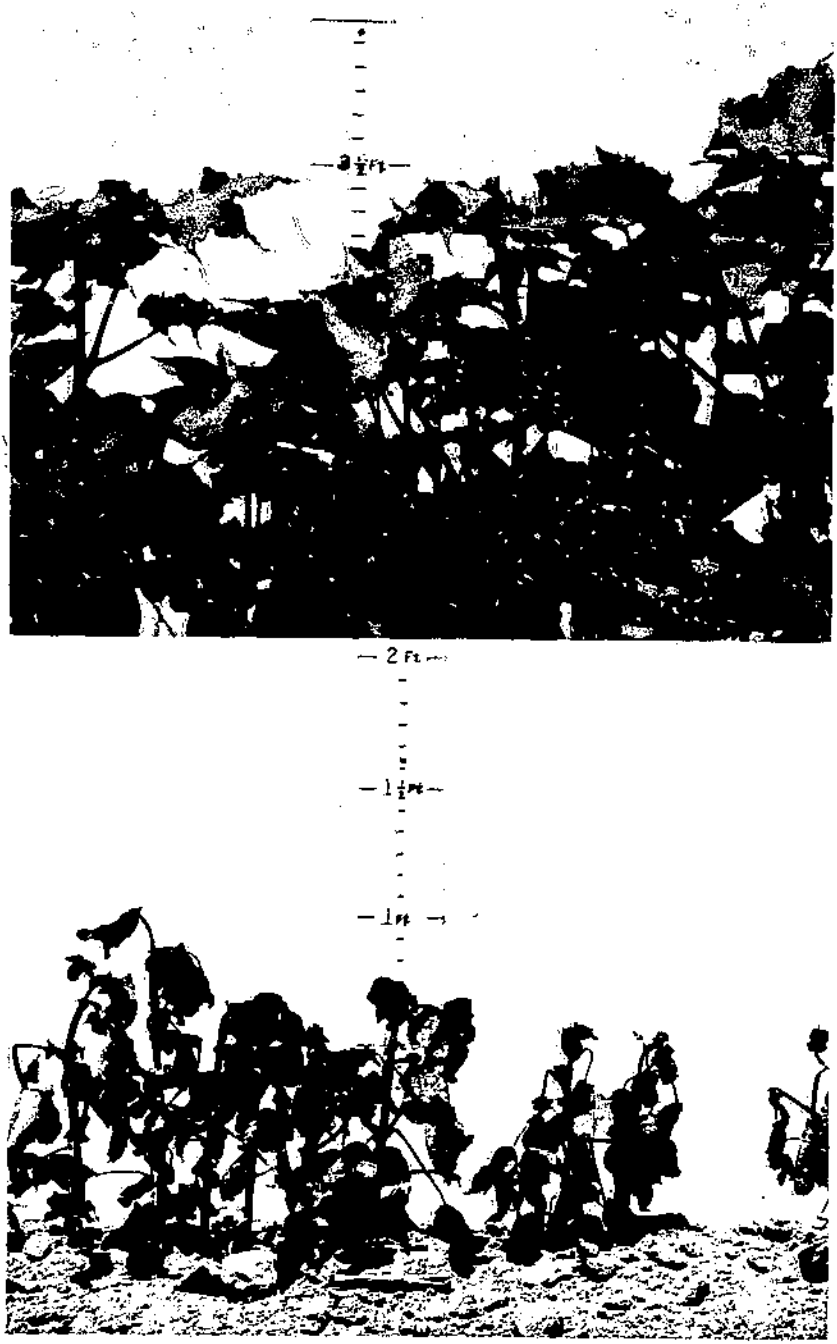

FIGURE 2.—Plant response 1 month after treatment to 0.001 (top) and 0.1 (bottom) pound per acre of 2,4,5-T applied as foliar sprays to cotton at the early-square stage.

an indication that perhaps much of the herbicide was effectively isolated in the dead tissues. At the end of the season the vegetation produced on the lateral buds showed few symptoms of the herbicide, except for delayed maturity. In fact, plants whose terminals had survived displayed much more epinasty.

The terminals of cotton plants were not killed by all rates of the herbicides that were applied at the full-bloom or early-boll stages of development. Seven weeks after the herbicide treatment of plants in the full-bloom stage, only 2,4-D had caused marked malformation of the leaves, the extent of which was correlated with the rate of application. The other herbicides caused only slight malformation. All herbicides, except at the low rate, caused abnormalities in the cotton flowers. The flowers that developed after treatment had fused petals and aborted reproductive organs. It appeared also that the abscission layer had failed to develop normally, and dead flowers remained on the plant. Again 2,4-D caused the greatest response, followed by 2,4,5-T, 2-(2,4-DP), and silvex. The same phenomenon was observed after herbicide treatment of plants in the early-boll stage of development. The treated plants failed to defoliate at harvest.

Comparisons of 2,4-D, 2,4,5-T, 2-(2,4-DP), and silvex with regard to plant malformations are shown in figures 1–4 on pages 4–7. The malformation caused by 2,4-D to individual plant organs is shown in figure 5.

Another secondary-growth response to the herbicide treatments was the formation of proliferated or gnarled callous tissue in the root-stem transition zone and primary-root system. This phenomenon was most pronounced in 2,4-D-treated plants, considerably less in 2,4,5-T-treated plants, and infrequent or absent in plants treated with the phenoxypropionic acids. The development of callous tissue was pronounced when 2,4-D was used at 0.1 pound per acre on cotton plants in both the early-square and full-bloom stages of development and when 0.01 pound was used on cotton in full bloom. When 2,4,5-T was used at 0.1 pound, proliferation of growth was pronounced on plants treated in both the early-square and full-bloom stages.

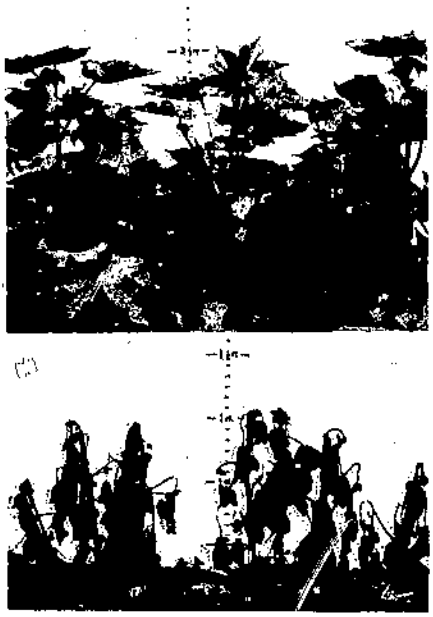

FIGURE 3.—Plant response 1 month after treatment to 0.001 (top) and 0.1 (bottom) pound per acre of 2-(2,4-DP) applied as foliar sprays to cotton at the early-square stage.

The effects of the four herbicides on the development of callous tissue are shown in figures 6 and 7.

The yields of seed cotton were reduced in 1954 by all herbicides and all rates of applications when treatments were made on cotton in the early-square stage of development, as shown in table 1. Similar results were obtained in 1955, except that 0.001 pound per acre did not reduce yields when 2,4,5-T, 2-

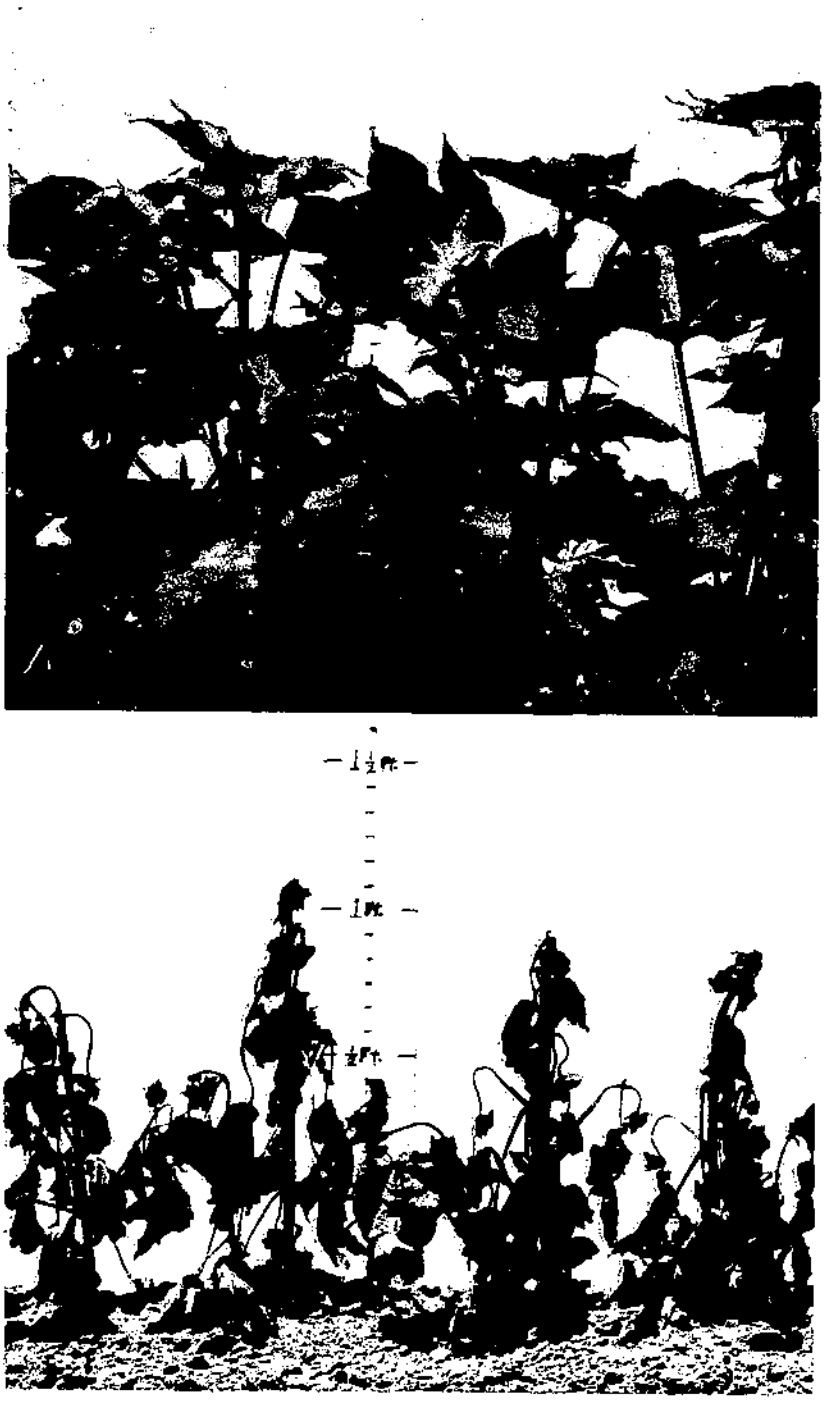

FIGURE 4.—Plant response 1 month after treatment to 0.001 (top) and 0.1 (bottom) pound per acre of silvex applied as foliar sprays to cotton at the early-square stage.

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FIGURE 5.—Typical response of various organs of cotton plant to foliage applications of 2,4-D: *A*, Leaf; *B*, terminal growth; *C*, squares and bracts; *D*, bloom; *E*, boll.

FIGURE 7.—Response of tissue in the root-stem transition zone of cotton to 0.1 pound per acre of 2,4,5-T (top) and of silvex (bottom) applied as foliar sprays at the early-square (*E*) and full-bloom (*F*) stages of development.

FIGURE 6.—Response of tissue in the root-stem transition zone of cotton to 0.1 pound per acre of 2,4-D (top) and of 2-(2,4-DP) (bottom) applied as foliar sprays at the early-square (*E*) and full-bloom (*F*) stages of development.

(2,4-DP), or silvex was used. Both 2,4-D and 2,4,5-T reduced yields of seed cotton when applied at the full-bloom stage, except when 0.0001 pound per acre was used in 1954. The 0.1- and 0.01-pound rates of 2-(2,4-DP) reduced yields, but the 0.001 and 0.0001 rates did not. Similar results were obtained with silvex, except that 0.001 pound per acre reduced yields in 1955. All herbicides reduced yields of seed cotton when applied at 0.1

TABLE 1.—*Effect on seed cotton yield of ester formulations of 2,4-D, 2,4,5-T, 2-(2,4-DP), and silvex applied on different dates in 1954 and 1955*

Herbicide and rate (pound per acre)	1954 yield per acre when herbicide was applied at indicated stage of plant growth on—			Average	1955 yield per acre when herbicide was applied at indicated stage of plant growth on—			Average
	June 18 (Early square)	July 23 (Full bloom)	August 19 (Early boll)		June 24 (Early square)	July 25 (Full bloom)	September 2 (Early boll)	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
None	2, 209	2, 399	2, 432	2, 346	2, 702	2, 601	2, 550	2, 626
2,4-D:								
0.0001		2, 083	2, 684					
.001	0	1, 452	2, 368	1, 298	808	1, 591	2, 399	1, 086
.01	0	442	2, 651		328	631	2, 298	
.1	0				25	126	1, 591	
2,4,5-T:								
0.0001		1, 927	2, 558					
.001	1, 548	1, 598	2, 432	1, 523	2, 475	2, 247	2, 651	1, 667
.01	416	917	2, 305		1, 520	1, 793	2, 525	
.1	0				152	76	1, 591	
2-(2,4-DP):								
0.0001		2, 242	2, 462					
.001	1, 160	1, 957	2, 242	1, 442	2, 525	2, 374	2, 828	1, 894
.01	253	538	2, 116		2, 298	1, 919	2, 727	
.1	0				505	253	1, 717	
Silvex:								
0.0001		1, 957	2, 399					
.001	1, 611	1, 704	2, 462	1, 462	2, 677	2, 247	2, 525	1, 793
.01	416	505	2, 116		1, 970	1, 717	2, 298	
.1	0				455	455	1, 843	
L.S.D. at 5-percent level	217	750	(1)		404	328	530	
L.S.D. at 1-percent level	289	997			530	429	682	

[1] Not significant.

pound per acre on cotton in the early-boll stage, but the other rates did not.

Yields were reduced much more by 2,4-D than by the other three herbicides in both years. Little yield differences among the other three herbicides could be detected. In 1954 the phenoxypropionic acids tended to reduce yield more than did 2,4,5-T; however, in 1955 the reverse tended to be true.

Response of Cotton to Soil Applications of Herbicides

Although the study spanned a 2-year period, it is impractical to attempt to combine years because the rates of application were altered. Within 3 days after the 1956 herbicide application, typical 2,4-D symptoms were apparent in all 2,4-D-treated plants, whereas only an occasional distorted leaf could be found among MCPA-treated plants. On the 2,4-D-treated plants, large numbers of flowers died but did not "abscise" as would normally be expected. The pedicels of the dead flowers remained green; apparently the abscission layer in the pedicel did not develop normally. Defoliation was likewise extremely poor on 2,4-D-treated plants. The leaves were killed by frost but did not abscise from the plant. These same features were noted to a limited extent on the MCPA-treated plants. Figure 8 shows the contrast between the 2,4-D- and MCPA-treated plots at harvest.

FIGURE 8.—Comparison at harvest of cotton plants treated at the early-square stage with soil applications of 2,4-D (left) and MCPA (right).

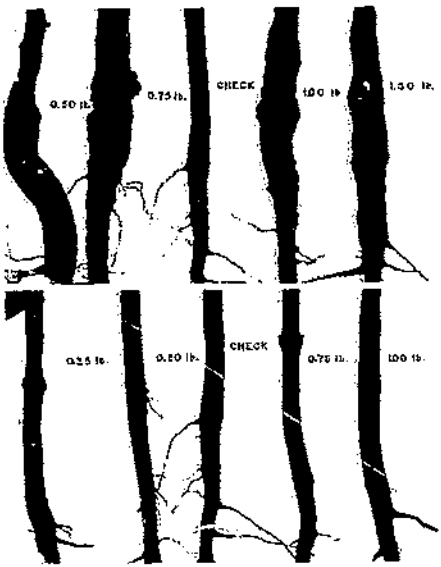

FIGURE 9.—Response of tissue in the root-stem transition zone of cotton to various rates of 2,4-D (top) and MCPA (bottom) used as side-dressed soil applications at the early-square stage.

After harvest, roots were selected at random and were removed from each of the treatments. The roots were examined and evaluated as to the amount of abnormality that occurred in the root-stem transition zone. The data showed that abnormalities were far more pronounced on the 2,4-D-treated plants. In figure 9 the abnormalities of roots of 2,4-D-treated plants are contrasted with those of MCPA-treated plants.

Although statistical significance was lacking, examination of the seed-index and boll-size data in table 2 shows that seeds from 2,4-D-treated plants tended to be larger

and bolls smaller than those from MCPA-treated or untreated plants. Although the number of seeds per boll was not determined, the trend toward smaller bolls and larger seeds may have been due to fewer seeds per boll.

Injury symptoms on the foliage in 1957 were much less pronounced than in 1956, when higher rates of

TABLE 2.—*Effect of side-dressed soil applications of alkanolamine salt formulations of 2,4-D and MCPA on cotton in 1956 and 1957*

1956

Herbicide and rate (pounds per acre)	Seed index	Boll size	Injury ratings [1]		Seed cotton yield
			Foliage	Taproot	
	Grams per 100 seeds	*Grams per boll*			*Pounds per acre*
None	14.0	7.9	0	0	3,682
2,4-D:					
0.50	15.8	7.8	7	8	1,512
.75	15.1	7.0	9	10	1,025
1.00	14.6	6.5	10	10	750
1.50	16.2	6.1	10	10	500
MCPA:					
0.25	14.0	8.5	1	0	2,962
.50	14.1	7.8	2	0	2,900
.75	15.6	8.7	3	0	2,800
1.00	14.4	7.7	3	1	2,750
L.S.D. at 5-percent level	[2]	[2]			547
L.S.D. at 1-percent level					795

1957

Herbicide and rate (pound per acre)	Seed cotton yield when herbicides were applied on—		Average
	June 3, 1957, and followed by four irrigations	June 17, 1957, and followed by nine irrigations	
	Pounds per acre	*Pounds per acre*	*Pounds per acre*
None	4,030	4,205	4,120
2,4-D:			
0.010	4,420	4,310	4,365
.025	4,290	4,570	4,430
.100	3,880	3,400	3,640
.250	3,725	2,535	3,130
MCPA:			
0.100	3,885	4,463	4,225
.250	4,095	4,140	4,120
.500	4,050	3,360	3,705
L.S.D. at 5-percent level	[2]	590	
L.S.D. at 1-percent level		820	

[1] Based on 0 for no injury to 10 for severe injury.
[2] Not significant.

TABLE 3.—*Effect of side-dressed soil applications of 2,4-D and MCPA on cotton fiber quality when two different irrigation schedules were used in 1957*

Herbicide and rate (pound per acre)	Effect on fiber characters [1] when herbicides were applied on—												
	June 3, 1957, and followed by four irrigations							June 17, 1957, and followed by nine irrigations					
	UHM	M	U	T_1	E_1	A	D	UHM	M	U	T_1	E_1	A	D
None	1.05	0.87	83	1.83	7.2	485	34	1.06	0.88	83	1.83	7.9	526	54
2,4-D:														
0.010	1.06	.87	82	1.88	7.0	456	37	1.08	.90	83	1.83	7.4	539	59
.025	1.08	.91	85	1.88	7.7	469	40	1.07	.90	84	1.77	7.5	536	58
.10	1.08	.91	84	1.85	7.2	464	34	1.08	.89	83	1.82	7.4	547	63
.25	1.04	.86	82	1.78	7.1	464	35	1.05	.87	83	1.84	7.4	571	59
MCPA:														
0.10	1.06	.90	85	1.81	7.4	467	42	1.04	.88	85	1.74	7.7	504	55
.25	1.08	.93	86	1.91	7.4	477	43	1.04	.87	84	1.83	7.8	527	55
.50	1.08	.90	83	1.81	7.1	457	39	1.05	.87	83	1.76	7.4	540	59

[1] Fiber characters from U.S. Dept. Agr., Crops Res., Results of 1960 Regional Cotton Variety Tests by Cooperating Agricultural Experiment Stations, ARS-34-30, Sept. 1961.

UHM—upper half mean—length in inches of half the fibers, by weight, which contains the longer fibers. Values approximate classer's staple.

M—mean—average length in inches of all fibers longer than ¼ inch.

U—uniformity—ratio of mean length to UHM expressed in percentage.

T_1—fiber strength of a bundle of fibers measured on the Stelometer with two jaws holding the fiber bundle separated by ⅛-inch spacer. Strength expressed in terms of grams per grex.

E_1—percentage elongation at break of the center ⅛ inch of the fiber bundle measured for "T_1" strength on the Stelometer.

A—Arealometer measurement—"A" is a measure of the external surface area of the fibers of a given volume of fibrous material expressed in terms of square millimeters per cubic millimeter of fibrous material.

D—Arealometer measurement—difference between the values of the specific area determined at "high pressure (A_H)" and the value of the specific area determined at standard pressure ("A" measured above). "D" is the measure of the flatness of the fiber ribbon; i.e., the higher the "D" value, the more ribbonlike are the fibers.

application had been used. At 0.01 pound per acre 2,4-D failed to produce injury symptoms. Only slight symptoms were produced with 0.025 pound and moderate to severe symptoms with 0.10 and 0.25 pound. MCPA, at the rates used, produced only slight to moderate injury symptoms on the cotton leaves. Unlike 1956, when great abnormalities occurred in the root-stem transition zone of plants treated with 2,4-D, none of the 1957 treatments caused noticeable injury.

In 1956, seed cotton yields were drastically reduced by the 2,4-D treatment, as shown in table 2. The reduction was in direct relation to the rate of application. The plants treated with MCPA produced about two or three times more cotton than those treated with 2,4-D at similar rates. However, the former produced less seed cotton than the untreated plants.

The yields of seed cotton in 1957 were not altered by either 2,4-D or MCPA when treatments were made at the very early-square stage and were followed by an infrequent irrigation schedule. When cotton was treated 2 weeks later and a more frequent irrigation schedule (comparable to that of 1956) was used, 0.25 and 0.10 pound per acre of 2,4-D and 0.50 pound per acre of MCPA caused reduced seed cotton yields. None of the herbicide treatments caused seed cotton yields to be increased.

Examination of the 1957 fiber-quality data for 2,4-D- or MCPA-treated plants fails to indicate any marked effects due to herbicide treatment, as shown in table 3. The A and D readings were different for the two dates of herbicide application, but close examination of the data for fiber of untreated plants indicates that these differences were due to the different irrigation treatments. The higher A and D readings obtained for fiber produced with nine irrigations indicate greater immaturity of fiber than was obtained with four irrigations.

Response of Cotton to Simulated Drift Rates of an Alkanolamine Salt Formulation of 2,4-D

The yields of seed cotton harvested at each of the two pickings and the total yields are shown in table 4. Although the yield data for the 2 years are generally in close agreement, certain deviations occur. At 0.1 pound per acre 2,4-D reduced seed cotton yields at the first picking at all dates of application in 1958 and all dates except August 15 in 1959.

Seed cotton yields at the first picking were also reduced by 0.01 pound per acre of 2,4-D at all dates of application, except on August 15 in 1958, and by similar treatments on June 15 and July 15 in 1959. None of the other treatments caused first-picking yield reductions.

In 1958 the second-picking data show that yields of seed cotton were reduced with 0.1 pound per acre of 2,4-D when applications were made on June 15 and August 15. Yield depressions with this rate of application appeared to be as great with the July 15 treatment, but could not be statistically supported. In 1959 the July 15 application of 0.1 pound per acre of 2,4-D was the only treatment in which the second-picking yield was reduced. In both years second-picking yields were significantly increased when 0.01 pound per acre of 2,4-D was applied on June 15, an indication that a part of the first-picking yield loss was recovered.

TABLE 4.—*Effect on seed cotton yield of low rates of an alkanolamine salt formulation of 2,4-D applied on different dates in 1958 and 1959*

1958

Rate of 2,4-D (pound per acre)	Yield per acre at designated picking when applications were made on—												Average		
	May 15			June 15			July 15			August 15					
	1st picking	2d picking	Total	1st picking	2d picking	Total	1st picking	2d picking	Total	1st picking	2d picking	Total	1st picking	2d picking	Total
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
0	3, 378	600	3, 978	3, 342	678	4, 020	3, 558	600	4, 158	3, 300	618	3, 918	3, 396	624	4, 020
.00001	3, 480	600	4, 080	3, 282	618	3, 900	3, 558	600	4, 158	3, 300	558	3, 858	3, 408	594	4, 002
.0001	3, 540	600	4, 140	3, 240	678	3, 918	3, 480	582	4, 062	3, 078	558	3, 642	3, 336	606	3, 942
.001	3, 624	558	4, 182	3, 258	600	3, 822	3, 498	660	4, 158	3, 138	678	3, 822	3, 372	624	3, 996
.01	2, 820	678	3, 498	2, 280	1, 098	3, 378	2, 382	558	2, 940	3, 042	582	3, 618	2, 634	726	3, 360
.1	1, 938	480	2, 418	222	342	558	1, 158	360	1, 518	2, 340	438	2, 778	1, 416	408	1, 818
Average	3, 132	588	3, 654	2, 604	672	3, 264	2, 940	558	3, 498	3, 036	576	3, 606	-------	-----	------
L.S.D. at 5-percent level	246	(1)	264	348	138	300	474	(1)	564	438	138	426	-------	-----	------
L.S.D. at 1-percent level	354	-----	378	492	192	426	672	-----	804	624	(1)	594	-------	-----	------

1959

0	2,160	408	2,568	2,244	492	2,736	2,160	456	2,616	2,244	540	2,784	2,202	474	2,676
.0001	2,112	420	2,532	1,992	528	2,520	2,184	456	2,652	1,992	492	2,484	2,070	474	2,550
.001	2,268	444	2,736	2,172	468	2,640	2,340	492	2,832	2,112	468	2,580	2,226	468	2,694
.01	2,196	372	2,568	1,296	744	2,040	1,452	444	1,896	2,100	492	2,592	1,764	516	2,274
.1	540	360	900	324	504	828	612	132	744	1,836	408	2,244	828	354	1,182
Average	1,854	402	2,256	1,608	546	2,154	1,752	396	2,148	2,053	480	2,538	-------	-----	------
L.S.D. at 5-percent level	408	(1)	402	366	186	360	378	66	414	(1)	(1)	306	-------	-----	------
L.S.D. at 1-percent level	564	-----	552	516	(1)	492	522	90	570	-------	-----	(1)	-------	-----	------

[1] Not significant.

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FIGURE 10.—Response 6 weeks after treatment of plants *A*, *B*, and *C* to 0.001, 0.01, and 0.1 pound per acre of 2,4-D, respectively, applied as foliar sprays to cotton on May 15. Note the retarded development of the central axis of plants *B* and *C*.

A pictorial record of plants treated with 2,4-D at 0.001, 0.01, and 0.1 pound per acre in 1958 is shown in figures 10–13. The morphological symptoms produced by 2,4-D treatments were very similar for both years. In each year very slight epinastic effects were observed on individual leaves of cotton after treatment with 0.001 pound per acre of 2,4-D on May 15, but on no other date with this rate. No morphological symptoms were observed with lower rates of 2,4-D on any of the four dates of application. 2,4-D injury symptoms with the 0.1 and 0.01 pound per acre were observed on all four dates of application but were different for each date.

When 2,4-D treatments were made on May 15, both 0.1 and 0.01 pound per acre arrested the terminal growth of cotton plants and eventually killed the central axis of most plants. Lateral branches, usually three or four, developed near the base of most plants prior to the death of the central axis. A few plants were killed by 0.1 pound per acre. The new growth on the lateral branches of plants treated with 0.01 pound per acre was nearly normal, whereas epinastic effects were evident on many of the leaves that developed on the lateral branches of plants treated with 2,4-D at 0.1 pound per acre.

Lateral branching had occurred at the time of the June 15 applica-

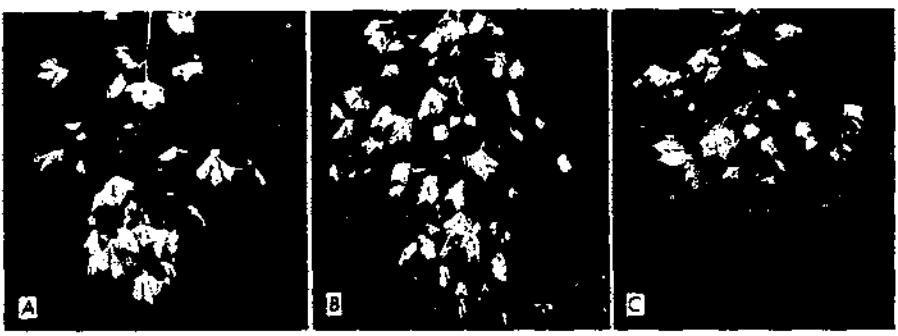

FIGURE 11.—Response 6 weeks after treatment of plants *A*, *B*, and *C* to 0.001, 0.01, and 0.1 pound per acre of 2,4-D, respectively, applied as foliar sprays to cotton on June 15. Note the epinasty in the terminal growth, particularly on plant *C*.

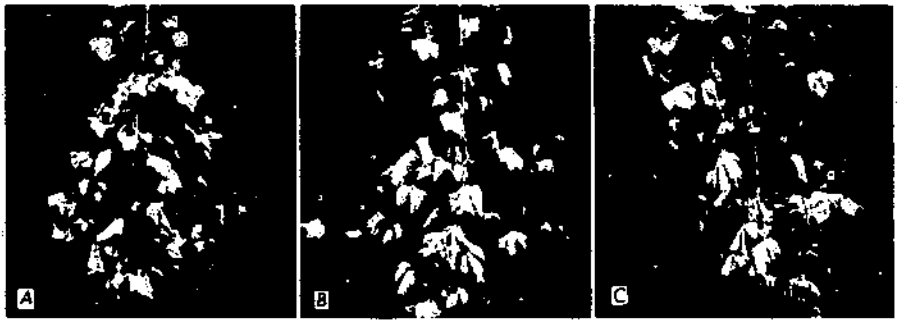

FIGURE 12.—Response 6 weeks after treatment of plants *A*, *B*, and *C* to 0.001, 0.01, and 0.1 pound per acre of 2,4-D, respectively, applied as foliar sprays to cotton on July 15.

tion of 2,4-D, and the central axis of most plants continued to be dominant. The fully expanded leaves remained nearly normal on plants treated with 0.1 pound per acre of 2,4-D, but severe epinastic effects occurred on the vegetative growth that developed after treatment. There were no open flowers at the time of application, and 2,4-D arrested the development of most fruiting organs. At 0.01 pound per acre the 2,4-D injury symptoms were similar to those at the 0.1-pound rate but much less severe. Although the vegetative growth after treatment was malformed to a great extent, many fruiting organs survived and produced small, poorly formed bolls.

By July 15 the cotton plants were nearing the maximal rate of flowering and had produced bolls varying up to full size. At 0.1 pound per acre 2,4-D caused marked epinasty in the terminal growth of the plant that developed after treatment and arrested development of many flowers and immature bolls. The few mature bolls appeared to develop normally. At 0.01 pound per acre 2,4-D caused symptoms very similar to those produced by treatment made a month earlier, except that the pronounced symptoms were confined to a much smaller area of the plant.

In both years the cotton plants had reached "cut-out" by August 15. Thus there was little further termi-

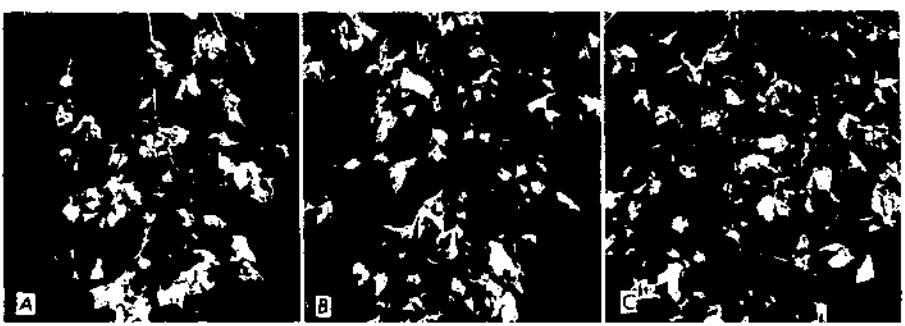

FIGURE 13.—Response 6 weeks after treatment of plants *A*, *B*, and *C* to 0.001, 0.01, and 0.1 pound per acre of 2,4-D, respectively, applied as foliar sprays to cotton on August 15.

nal growth, and very few epinastic effects were observed. At 0.1 pound per acre 2,4-D killed many small bolls, flowers, and squares and caused curling and death of numerous mature leaves in a manner typical of contact-type herbicides. At 0.01 pound per acre 2,4-D caused similar but less extensive symptoms. The plants treated in August failed to defoliate properly. This was particularly noticeable with 2,4-D at the two higher rates of application. The herbicide treatments appeared to "freeze" the leaves on the plant by arresting the development of the normal abscission layer in the leaf petiole. Because 0.1 and 0.01 pound per acre of 2,4-D applied on May 15 killed the primary or central axis of the plant, all seed cotton was produced on lateral or secondary growth. This caused the plant to be considerably shorter than normal at harvest. With 0.01 pound per acre, epinastic effects were not generally apparent in the secondary growth, although with the higher rate epinastic effects were marked, an indication that much more 2,4-D was being transported in the plant.

The 0.1 and 0.01 pound per acre of 2,4-D applied on June 15 produced the most marked epinastic effects of any treatment date, as measured by the appearance of the plants at the time of the first picking. Seed cotton yields were greatly reduced by these treatments. The injury produced with 0.1 pound per acre of 2,4-D persisted throughout the remainder of the season, whereas there was some recovery with 0.01 pound. This was evident because this treatment was the only one in which second-picking yields were improved as compared with yields of untreated plants.

The yields of cotton treated with 0.1 and 0.01 pound per acre of 2,4-D on July 15 likewise were reduced. There was no indication from second-picking yields that plants recovered from these treatments. Production from plants treated with these two rates of 2,4-D in July was obtained mostly from bolls that were already on the plant at the time of treatment.

By August 15, 90 to 95 percent of the total cotton crop can be expected to be "set" on the plants. Flowers formed by September 1 will frequently produce an open boll. The reduced total yield with 0.1 pound per acre of 2,4-D is probably due to the fact that treatment arrested the development of immature bolls and prevented boll set from flowers produced subsequent to treatment.

There was no evidence of increased seed cotton yields with 2,4-D at any of the rates used on the four application dates.

The effects of foliar applications of 2,4-D on fiber and boll properties are shown in table 5. These data indicate that none of the application rates of 2,4-D had marked effects on fiber and boll properties except 0.1 pound per acre.

At 0.1 pound per acre 2,4-D applied on May 15 reduced the boll size and lowered the lint index. A similar application made on June 15 reduced the uniformity of fiber length, caused immaturity of fiber, and reduced boll size. The July application shortened fiber length, impaired maturity, and reduced boll size. Similar results were obtained for the August 15 application in 1958, but no detrimental effects were observed in 1959. The experiment was located on a lighter soil in 1959, and this factor may well have caused the plants to be more mature at the time of the August application in that year.

Progeny Response of Cotton Treated With Herbicides

Seed was saved from certain of the herbicide experiments in these studies to determine the effects of the herbicides on seed quality. Factors considered were germination, seedling vigor, appearance of seedling plants, and productivity.

Progeny Response of Cotton Plants Treated With Side-Dressed Soil Applications of 2,4-D and MCPA

The plant-emergence data and seed cotton yields of progeny from 1956 herbicide treatments and grown in 1957 are shown in table 6. The progeny-emergence data show that 0.75, 1.0, and 1.5 pounds per acre of 2,4-D impaired seed quality as reflected by reduced germination. Delayed emergence was also encountered with the same treatments. The emergence from seed of the MCPA-treated plants was not different from that of untreated plants. No malformed seedlings were observed from MCPA-treated plants. In addition, the seedlings as indicated by cotyledon size appeared to show more vigor than seedlings from untreated plants. The seedlings from 2,4-D-treated plants were reduced in vigor. Approximately 10 percent of the seedlings from plants treated with the 1.5 pounds per acre of 2,4-D had malformed first true leaves. These leaves were long, narrow, and crinkled, as shown in figure 14. Normal seedlings were produced from plants treated with the lower rates of 2,4-D.

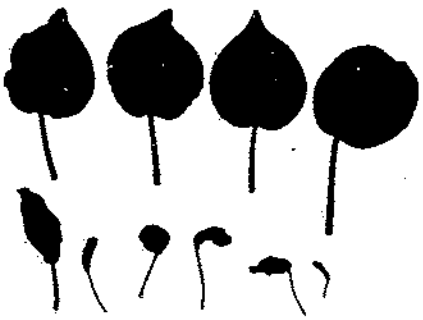

FIGURE 14.—Malformed first true leaves (bottom) of progeny of cotton plants treated with 2,4-D compared with leaves of progeny of untreated plants (top).

The seed cotton yields from progeny of 2,4-D-treated plants were not reduced, but a definite trend toward reduced yields was shown with progeny of plants treated with 1.5 pounds per acre. The seed cotton yields from progeny of plants treated with the various rates of MCPA were not different from each other, nor were they different from yields of progeny of untreated plants. However, there appeared to be a tendency for progeny of MCPA-treated plants to yield more than progeny of untreated plants.

The same lots of seed were again planted in 1958. However, slight changes in methods occurred. The floating seed in the delinting process was discarded in 1957, but not in 1958. Emergence counts were made at earlier dates in 1958. It should be noted that cottonseed held in storage for a year often will germinate more rapidly than new seed. This is vividly shown by comparing the early-emergence data of 1956 lots of seed from untreated plants grown in 1957 and 1958. (See tables 6 and 7.)

The progeny response of plants treated with herbicides in 1956 but planted in 1958 is shown in table 7. The plant-emergence data, although collected at earlier dates, are in close agreement with those collected a year earlier. It was again shown that plants treated with 0.75, 1.0, and 1.5 pounds per acre of 2,4-D produced seed of impaired quality.

TABLE 5.—*Effect of foliage applications of 2,4-D on cotton fiber and seed quality in 1958 and 1959* [1]

1958

Date and rate of 2,4-D (pound per acre)	Fiber characters [2]						Boll characters [3]				Percent of crop harvested at 1st picking
	UHM	M	U	T_1	A	D	Lock weight	Seed index	Lint index	Lint percent	
May 15:											
0	1.11	0.90	81	1.93	475	19	1.8	13.5	8.7	39.3	85
.00001	1.07	.89	83	2.05	433	12	1.7	13.2	8.6	39.5	85
.0001	1.06	.86	81	1.95	456	15	1.7	13.0	8.6	40.0	86
.001	1.10	.89	81	1.93	475	22	1.7	13.0	8.4	39.2	87
.01	1.08	.87	81	1.98	465	16	1.6	12.9	8.6	40.0	81
.1	1.10	.89	81	2.03	491	25	1.6	12.5	8.1	39.2	80
June 15:											
0	1.09	.89	82	1.89	446	16	1.7	13.2	8.9	40.4	83
.00001	1.07	.86	81	1.99	460	21	1.8	13.4	8.9	39.8	84
.0001	1.07	.85	80	1.93	461	17	1.8	13.1	8.2	38.6	83
.001	1.05	.83	79	1.98	497	31	1.6	13.1	8.5	39.3	85
.01	1.10	.88	80	2.08	495	21	1.6	13.4	8.1	37.7	67
.1	1.04	.79	76	2.09	630	41	1.1	12.4	8.6	41.0	40
July 15:											
0	1.08	.86	82	1.94	450	12	1.7	13.4	9.1	40.5	86
.00001	1.08	.87	81	2.02	461	18	1.7	12.8	8.6	40.2	86
.0001	1.08	.89	82	1.85	440	9	1.7	13.0	8.6	39.8	86
.001	1.08	.91	84	1.98	441	16	1.8	13.5	9.0	40.0	84
.01	1.08	.86	80	2.01	457	17	1.8	13.9	9.0	38.3	81
.1	1.05	.82	78	1.96	511	31	1.5	11.9	8.0	40.2	76
August 15:											
0	1.08	.89	83	1.99	437	10	1.8	13.9	9.4	40.4	84
.00001	1.08	.88	81	1.98	431	9	1.7	13.0	7.8	39.8	86
.0001	1.06	.84	80	1.92	444	14	1.7	13.2	7.9	40.0	85
.001	1.08	.89	82	1.83	438	14	1.7	13.6	9.1	40.1	82
.01	1.08	.87	81	2.05	452	15	1.7	13.9	9.0	39.7	84
.1	1.06	.84	79	1.95	506	32	1.5	12.3	6.3	39.1	84

May 15:											
0	1.09	0.91	83	1.98			1.5	13.9	8.7	38.8	84
.0001	1.09	.91	83	1.99			1.5	13.4	8.5	38.9	83
.001	1.10	.90	83	1.98			1.6	13.5	8.7	39.1	83
.01	1.12	.93	82	1.96			1.4	13.2	8.4	38.6	86
.1	1.12	.90	80	2.00			1.2	12.1	7.0	36.6	60
June 15:											
0	1.11	.93	84	1.98			1.6	13.9	8.8	38.8	82
.0001	1.09	.90	83	2.03			1.5	13.5	8.5	38.6	79
.001	1.09	.90	82	1.99			1.5	13.6	8.6	38.7	82
.01	1.09	.87	80	2.09			1.3	12.9	7.6	37.4	64
.1	1.11	.85	77	2.07			1.1	13.6	7.5	35.6	39
July 15:											
0	1.10	.92	83	2.02			1.6	13.5	8.7	38.8	83
.0001	1.09	.90	83	2.00			1.6	13.5	8.8	39.2	82
.001	1.10	.91	83	2.00			1.6	13.8	8.8	38.8	83
.01	1.07	.87	81	2.07			1.5	14.0	8.4	37.6	77
.1	1.03	.83	81	1.99			1.3	11.4	7.6	40.1	82
August 15:											
0	1.09	.91	83	2.04			1.6	13.8	8.9	39.1	81
.0001	1.10	.91	83	2.00			1.5	13.4	8.5	38.9	80
.001	1.09	.90	82	2.02			1.6	13.7	8.8	38.9	82
.01	1.09	.90	82	2.01			1.6	13.8	8.7	38.6	81
.1	1.09	.90	82	2.04			1.5	13.7	8.8	37.9	82

[1] First-picking data.
[2] See table 3, footnote 1.
[3] Boll characters:
Lock weight—weight in grams of the contents (seed and lint) of one locule of a cotton boll. Used as an estimate of boll size.
Seed index—weight in grams of 100 fuzzy seeds (seed after lint removed by ginning).
Lint index—weight in grams of lint or fibers ginned from 100 seeds.
Lint percent—weight of lint ginned from a sample of seed cotton expressed as a percentage of weight of seed cotton (seed and fibers).

TABLE 6.—*Effect of 2,4-D and MCPA on progeny grown in 1957 from cotton plants treated in 1956 with side-dressed soil applications of herbicides*

Herbicide and rate (pounds per acre) of parental treatment (1956)	Progeny emergence per 0.002 acre at designated days after planting					Seed cotton yield per acre[1]
	14	15	16	17	37	
	Number	*Number*	*Number*	*Number*	*Number*	*Pounds*
None	72	81	86	86	84	3, 202
2,4-D:						
0.50	66	72	73	75	75	3, 333
.75	52	55	61	65	68	3, 365
1.00	54	61	65	68	70	3, 202
1.50	40	47	52	55	59	2, 973
MCPA:						
0.50	73	78	82	81	81	3, 496
.75	74	80	84	85	86	3, 496
1.00	81	86	91	93	90	3, 496
L.S.D. at 5-percent level	15	11	10	11	13	302
L.S.D. at 1-percent level	20	14	13	15	18	(2)

[1] 26,000 plants per acre population.
[2] Not significant.

The 1957 data (table 6) indicate that 0.5 pound per acre may also have impaired seed quality. The 1958 data supported the evidence insofar as delayed emergence was concerned. The 1958 data relative to the emergence of seed from MCPA-treated plants again show no evidence of impaired seed quality.

Malformed first true leaves were observed on progeny of plants treated with 0.75, 1.0, and 1.5 pounds per acre of 2,4-D. As in 1957 little evidence of malformed leaves was found on progeny of MCPA-treated plants.

Although statistical significance was lacking in 1957, certain yield trends were evident. The 1958 yield data did not support these trends.

Progeny responses of plants treated in 1957 with side-dressed soil applications of 2,4-D and grown in 1958 are shown in table 8. The plant-emergence data show that 0.25 and 0.1 pound per acre impaired the quality of seed. These were lower rates than those used a year earlier. There also was some indication that perhaps even lower rates may have reduced germination. Progeny of plants treated with MCPA at 0.25 and 0.5 pound per acre in 1957 showed slight evidence of reduced germination.

In the progeny of plants treated with herbicides in 1957, there was little if any indication of malformed true leaves. There likewise was no evidence of reduced seed cotton yields.

Progeny Response of Cotton Plants Treated With Foliar Applications of 2,4-D

The greenhouse study covered a period of 10 days after planting. Cotton seedlings began to emerge on the third day and daily plant counts were made at 4 p.m. for 8 days. The flats were left in the greenhouse for several more days, but no further emergence was noted.

TABLE 7.—*Effect of 2,4-D and MCPA on progeny grown in 1958 from cotton plants treated in 1956 with side-dressed soil applications of herbicides*

Herbicide and rate (pounds per acre) of parental treatment (1956)	Progeny emergence per 0.002 acre at indicated days after planting							Malformed leaves per 100-foot row	Seed-cotton yield per acre [1]
	6	7	8	10	12	17	24		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Pounds*
None	81	102	107	110	109	110	110	0.6	3,125
2,4-D:									
0.50	48	75	92	102	102	102	103	2.6	3,150
.75	48	77	87	93	95	98	96	7.0	3,075
1.00	40	68	78	85	87	88	86	4.6	3,000
1.50	23	43	57	68	72	73	76	8.2	2,800
MCPA:									
0.50	76	103	110	114	113	114	114	.6	2,875
.75	60	95	106	111	111	111	111	.6	3,025
1.00	75	104	113	115	116	117	115	.8	2,900
L.S.D. at 5-percent level	21	12	8	9	9	9	9	----------	[2]
L.S.D. at 1-percent level	28	17	11	11	12	12	12	----------	----------
C.V. (percent)	29	11	7	7	7	7	7	----------	----------

[1] 32,500 plants per acre population.
[2] Not significant.

TABLE 8.—*Effect of 2,4-D and MCPA on progeny grown in 1958 from cotton plants treated in 1957 with side-dressed soil applications of herbicides*

Herbicide and rate (pound per acre) of parental treatment (1957)	Progeny emergence per 0.002 acre at indicated days after planting							Malformed leaves per 100-foot row	Seed cotton yield per acre [1]
	6	7	8	10	12	17	24		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Pounds*
None	29	61	80	97	102	107	108	0.2	3,100
2,4-D:									
0.01	28	51	76	89	93	94	94	.2	3,375
.025	33	64	82	94	99	102	102	0	3,175
.10	17	43	64	83	86	90	90	.8	3,075
.25	19	44	62	77	81	85	85	.2	3,250
MCPA:									
0.10	37	65	88	100	102	104	104	.2	3,150
.25	23	55	75	89	94	95	96	.4	3,100
.50	23	55	76	87	89	92	92	.4	2,900
L.S.D. at 5-percent level	[2]	16	12	10	8	8	9	----------	[2]
L.S.D. at 1-percent level	[2]	[2]	16	13	11	11	12	----------	----------
C.V. (percent)	44	22	12	8	7	6	7	----------	----------

[1] 32,500 plants per acre population.
[2] Not significant.

TABLE 9.—*Emergence and yield of progeny grown in 1959 from cotton plants treated in 1958 with foliar applications of 2,4-D*

Date and rate (pound per acre) of parental treatment (1958)	Progeny emergence at indicated days after planting [1]								Seed cotton yield per acre [2]
	3	4	5	6	7	8	9	10	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Pounds*
May 15:									
0	0	37	69	85	92	94	94	95	2,730
.00001	1	38	90	93	92	91	91	95	2,574
.0001	0	42	77	86	86	86	87	88	2,548
.001	1	43	82	90	92	92	92	92	2,886
.01	0	38	71	80	82	82	86	86	2,522
.1	0	28	71	87	91	90	90	91	2,522
June 15:									
0	0	41	86	87	87	87	88	90	2,548
.00001	0	61	92	93	94	94	94	96	2,860
.0001	0	59	91	91	91	93	92	94	2,886
.001	0	47	84	86	86	86	86	87	2,496
.01	0	31	73	88	88	90	90	90	2,600
.1	0	6	24	34	38	42	47	48	1,638
July 15:									
0	0	15	66	82	89	90	90	91	3,198
.00001	0	26	63	85	88	90	90	90	2,678
.0001	0	10	63	90	94	95	94	94	2,912
.001	0	10	73	91	94	94	94	96	2,964
.01	0	14	54	70	75	84	85	86	[3] 2,860
.1	0	1	1	1	1	1	1	1	104
August 15:									
0	0	19	71	88	94	94	94	94	[3] 3,640
.00001	0	20	71	74	80	81	82	82	2,834
.0001	0	17	64	82	86	88	89	89	2,574
.001	0	29	69	82	83	82	82	85	2,522
.01	0	6	31	47	55	63	74	80	1,768
.1	0	2	24	34	36	34	35	37	1,430

[1] Average of five replications. [2] Nonreplicated. [3] Yield influenced by border effect.

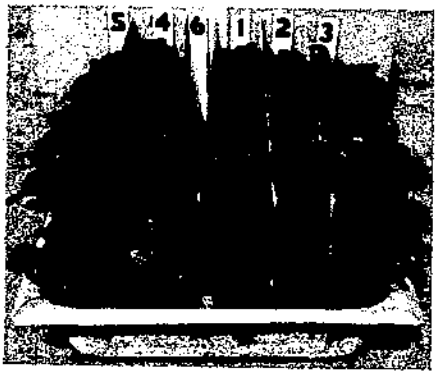

FIGURE 15.—Progeny of cotton plants treated with various rates (pounds per acre) of 2,4-D applied on July 15: (1) Untreated, (2) 0.00001, (3) 0.0001, (4) 0.001, (5) 0.01, and (6) 0.1. Note the absence of germinated progeny of plants treated with 0.1 pound per acre.

Examination of the data in table 9 shows that the quality of seed produced by plants treated with 0.1 pound per acre of 2,4-D in June, July, and August was markedly impaired. Seed produced by plants treated at this rate in July was so impaired that there was practically no germination, as shown in figure 15.

Seed produced by plants treated with 0.01 pound per acre of 2,4-D may likewise have been impaired. Although final emergence may not have been reduced, the rate of emergence was decreased with seed from plants treated in August. The same trend, but to a lesser degree, appeared with seed from plants treated in July.

These conclusions were supported by the yields of seed cotton from the field rows. The one possible exception was yields from seed of plants treated with 0.01 pound per acre of 2,4-D applied in July. However, the fact that this yield row bordered a row producing practically no cotton undoubtedly affected the yield.

Observations in the field failed to show any appreciable malformation of leaves on the progeny of plants treated with 2,4-D. However, a few seedling plants of the greenhouse study produced first true leaves that displayed symptoms of 2,4-D. These symptoms were found only on progeny from plants treated with 0.1 pound per acre in June, July, and August.

SUMMARY

Response of Cotton to Foliage Applications of Herbicides

1. Low rates of the ester formulations of 2,4-D, 2,4,5-T, 2-(2,4-DP), or silvex caused severe injury to cotton. The injury was correlated with the rate of application and decreased as the application date was delayed.

2. Among the herbicides, 2,4-D caused far greater damage to cotton than 2,4,5-T, 2-(2,4-DP), or silvex. Little difference, except in morphological malformation, was observed in cotton treated with the last three herbicides.

3. None of the herbicides at the rates used tended to increase yields of cotton.

4. Morphological malformations caused by the herbicides were dissimilar. The phenoxyacetic acid herbicides caused pronounced "strapping" of leaves and frequently caused proliferation of callous tissues in the root-stem transition zone of the plant. The phenoxypropionic acid herbicides caused "cupping" of the leaves and showed little tendency to cause proliferation of root-stem tissues. All herbicides retarded defoliation of the plants and caused malformed flowers.

Response of Cotton to Soil Applications of Herbicides

1. An alkanolamine salt formulation of 2,4-D, when used as side-dressed soil applications, caused greater damage to cotton than similar treatments with an alkanolamine salt formulation of MCPA. This was evidenced both by seed cotton yields and morphological abnormalities.

2. Neither 2,4-D nor MCPA at the rates used resulted in increased seed cotton yields.

Response of Cotton to Simulated Drift Rates of an Alkanolamine Salt Formulation of 2,4-D

1. Cotton plants were damaged by an alkanolamine formulation of 2,4-D at rates as low as 0.01 pound per acre.

2. 2,4-D at concentrations that caused marked epinasty of cotton plants also reduced seed cotton yields.

3. Seed cotton yields were reduced most drastically by applications of 2,4-D at 0.1 and 0.01 pound per acre during the flowering and fruit-setting periods of plant development (June and July). Yields were also depressed by these rates of 2,4-D applied to cotton in early vegetative stages of growth, but some recovery occurred. Although the central axis of the plant was killed or greatly retarded, recovery was manifested in the development of lateral vegetative branches. A part of the 2,4-D may have been isolated and trapped in the dead tissues of the plant.

4. 2,4-D applied at 0.1 pound per acre after "cut-out" of the cotton plant reduced total yield. Vegetative growth for the most part had ceased and few epinastic responses were observed. The reduced yields were probably due to the arrested development of immature bolls.

5. Rates of 2,4-D as low as 0.01 pound per acre applied as foliar sprays on cotton retarded defoliation.

6. Foliar applications of 2,4-D varying from 0.1 to 0.00001 pound per acre on four different dates did not increase cotton yields.

Progeny Response of Cotton Treated With Herbicides

1. The data showed that cotton plants treated with low rates of 2,4-D produced seed of inferior quality.

2. The reduced quality was manifested by both reduced and delayed germination.

3. Malformed first true leaves of progeny of plants treated with certain rates of 2,4-D showed that epinastic responses could be transmitted.

4. The quality of seed from plants treated with 2,4-D was impaired markedly compared with seed from plants treated with MCPA.

Effect of Herbicides on Fiber Quality of Cotton

1. Fiber-quality data obtained on plants treated with soil applications of 2,4-D or MCPA failed to show any marked effects due to herbicide treatment.

2. Fiber quality was impaired by foliar applications of 2,4-D at 0.1 pound per acre. The reduced fiber quality was most marked with applications made in June and July. Little, if any, effect on fiber quality was observed when plants were treated at lower rates.

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U.S. GOVERNMENT PRINTING OFFICE: 1963 O—676009

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